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OF THE MECHANICAL ORIGINE OF *HEAT* and *COLD*.

By the Honourable
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Fellow of the *R. Society*.

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The Publiſher's Advertiſement to the READER.

I Shall not entertaine the Reader with any thoughts of my own, about the following Appendix, which, without deſiring to prepoſſeſs him, I ſhall willingly (and I thinke may ſafely) leave to ſpeak for it ſelfe. But yet I think it may not be amiſs, if I premiſe ſomething to the Reader, about the publication of theſe Notes, as having been particularly concern'd in it.

By the opportunity I had of ſeeing ſome papers, of the Honourable Author of the enſuing Appendix;

I perceived that the Notes which he deſign'd it ſhould conſiſt of, were indeed moſt of them laid together in ſome (though but a careleſs) order, and ſo were without much difficulty fitted for the Preſs: but others of them lay ſcatter'd up and down amongſt many others, about differing ſubjects in his Philoſophical Memorials, which particulars not being ready at hand, when the Enſuing Notes *were ſent to* Oxford *to the* Printer, *they could not be publiſh'd with the reſt, but muſt expect ſome other opportunity, to appear abroad, either alone, or in their company.*

Perhaps the Reader will not need to be told that beſides the Application of ſome of the Experiments contained in the following Notes, moſt of the Experiments themſelves are new. But ſo many years are paſt, betwixt

betwixt the firſt *Edition of the* Sceptical Chymiſt, *and the* ſecond *that now comes forth; that it may be requiſite (though otherwiſe it would be improper) to advertiſe this Reader, that he is not to think, that the Author has borrowed from others thoſe Experiments and Notions, that may be met with in Bookes written in later years, as well as in the* Sceptical Chymiſt. *For the firſt* Engliſh *Edition having been put forth in the year* 1661. *and never ſince by the Author at all enlarg'd, or alter'd; 'twill ſufficiently ſhew that this Book could not borrow from thoſe that never were ſeen till after, and perhaps long after* his *was publiſhed. Which Advertiſement may be particularly apply'd to the late Learned Treatiſe, Intituled* Philoſophia Vetus & Nova, *wherein in one long Chapter may be*

met with an Abridgment of a great part of the Notions, Experiments and Ratiocinations of the Sceptical Chymist, without any mention there made, either of the great and famous Authors Name, or his Book in which they first appear; Though the Latine Version of that Treatise, was publish'd many years ago, and reprinted many times since. And though this be not the only Writer, that hath thought fit to make use of considerable portions of the Sceptical Chymist, without owning it, I thought, what he has been pleas'd to do, required to have particular Notice taken of it: because, though his modesty hath perswaded him to conceal his Name, his Learned Book hath made him so justly famous, that if the Reader were not advertis'd, he might easily suspect, that Mr Boyle had not lent to, but borrowed

ed of an Author, who appears ſo capable of enriching the Curious with excellent things of his own. And upon the ſame grounds I thinke it neceſsary to obſerve, that the Experiments to be met with in Mr. Boyles Hiſtoy of Colours, *having been publiſh'd many years ago, could not be borrow'd from that moſt ingenious Treatiſe, though in that Chapter of it which treates* de coloribus, *between* 20. *and* 30. *Experiments, (If I miſremember not the number) will be found the ſame with the like Number of* Mr. Boyles; *whoſe Name, though elſewhere very civilly taken notice of on ſome other occaſion, is in that whole Chapter left unmention'd.*

I might here informe the Reader, that the Sceptical Chymiſt *having been many years out of Print, it chanc'd that when the*

Notes,

Notes, that make up the following Appendix, were drawn together for the Press, this Author had not a Book at hand, by comparing whereof with the particulars of his design'd Appendix, he might be sure to avoid, (what he now but hopes *he hath;) the suffering any thing to passe in the latter, that is truly coincident, with what was already extant in the former: (I mean, to the same purpose, and on the same occasion; for otherwise an Experiment or Notion may be more then once employ'd without meer Repetition.)*

And lastly I dare not omitt to let the Reader know, that since the Appendix was printed, it appears, that by an oversight, some leaves were left behind, that treating of the difference of Common Mercury's *themselves, should have been annex'd, as a kind of Appendix, to the last of the three*

three Mercurial Tracts, to be met with among the following papers: from whoſe peruſall the Reader ſhall no longer be detain'd by

His

Humble Servant

I. M.

Experiments and Notes ABOUT THE MECHANICAL ORIGINE OR PRODUCTION OF *HEAT* and *COLD.*

SECT. I.

About the Mechanical Production of Cold.

HEAT & *COLD* being generally lookt upon as the moſt active among Qualities, from which many other Qualities are deducible, and by which many of Nature's Phænomena, eſpecially among the

Peripateticks, are attempted to be explicated; I ſuppoſe it will be very proper to begin with Inſtances of them to ſhew, that Qualities may be Mechanically produced or deſtroyed. A not uſeleſs Paraphraſe of which expreſſion may be this, That a portion of matter may come to be endowed with a Quality, which it *had not* before, or to be deprived of one that it had, *or* (ſometimes) to acquire or loſe a degree of that Quality; *though* on the part of the Matter (or, as ſome would ſpeak, of the Patient) there do not appear to intervene any more than a change of Texture, or ſome other Mechanical Alteration; and *though* the Agents (on their part) do not appear to act upon it otherwiſe, than after a Mechanical manner, that is, by their bigneſs, ſhape, motion, and thoſe other Attributes by vertue whereof Mechanical Powers and Engines perform their operations; and this without having recourſe to the Peripatetic Subſtantial Forms and Elements,

ments, or to the Hypoſtatical Principles of the Chymiſts.

And having here (as in a proper place) to avoid ambiguity, premiſed once for all, this *Summary Declaration of the ſenſe, agreeably whereunto I would have theſe Terms underſtood in the following Notes about the Origine of Particular Qualities; I proceed now to ſet down ſome few examples of the Mechanical Production of *Cold* & *Heat*, beginning with thoſe that relate to the former, becauſe by reaſon of their Paucity they will be quickly diſpatcht. And I hope I ſhall not need to make an Apology for mentioning no greater number; ſince I ſcarce remember to have met with any Inſtances of this kind in any of the Claſſick Writers of Natural Philoſophy.

* See more of this in the Preamble.

EXPER. I.

MY firſt Experiment is afforded me by the Diſſolution of Sal Armoniac, which I have ſomewhat wonder'd, that Chymiſts having often occaſion to purifie that Salt by the help of Water, ſhould not have, long ſince, and publickly, taken notice of. For if you put into three or four times its weight of Water a pound or but half a pound (or even leſs) of powder'd Sal Armoniack, and ſtir it about to haſten the diſſolution, there will be produc'd in the mixture a very intenſe degree of Coldneſs, ſuch as will not be onely very ſenſible to his hand that holds the Glaſs whilſt the Diſſolution is making, but will very manifeſtly diſcover it ſelf by its Operation upon a Thermoſcope. Nay, I have more than once by wetting the outſide of the Glaſs, where the diſſolution was making, and nimbly ſtirring

ring the Mixture, turn'd that externally adhering water into real Ice, (that was scrap'd off with a knife) in less than a minute of an hour. And this thus generated Cold continued considerably intense, whilst the action of dissolution lasted; but afterwards by degrees abated, and within a very few hours ceas'd. The particular Phænomena I have noted in the Experiment, and the practical uses that may be made of it I reserve for another place*, the knowledge of them being not necessary in this, where what I have already related, may suffice for my present Argument.

* Divers of the Phænomena, &c. of this Experiment were afterwards printed Numb. 15. of the *Ph. Transact.*

And to shew, that not onely a far more intense degree of Cold may emerge in this Mixture, than was to be found in either of the Ingredients before they were mingled, but a considerable Coldness may be *begun* to be produc'd between Bodies that were neither of them actually Cold

before they were put together, I will ſubjoin a Tranſcript of what I find to this purpoſe among my *Adverſaria*.

EXPER. II.

I Remember that once I had a mind to try, Whether the Coldneſs produced upon the Solution of beaten Sal Armoniac in water, might not be more probably referr'd to ſome change of Texture or Motion reſulting from the action of the Liquor upon the Salt, than to any Infrigidation of the water made by the ſuddain diſperſion of ſo many Saline grains of powder, which by reaſon of their Solidity may be ſuſpected to be actually more cold than the Water they are put into; I therefore provided a Glaſs full of that Liquor, and having brought it to ſuch a Temper, that its warmth made the Spirit of Wine in the ſeal'd Weather-glaſs ma-

manifeſtly, though not nimbly, aſcend; I took out the Thermoſcope, and laid it in powder'd Sal Armoniac, warm'd beforehand; ſo that the tinged Liquor was made to aſcend much nimblier by the Salt than juſt before by the Water; and having preſently remov'd the Inſtrument into that Liquor again, and poured the ſomewhat warm Sal Armoniac into the ſame, I found, as I imagin'd, that within a ſpace of time which I gueſs'd to be about half a minute or leſs, the Spirit of Wine began haſtily to ſubſide, and within a few minutes fell above a whole diviſion and a quarter below the mark at which it ſtood in the water, before that Liquor or the Salt were warm'd. Nor did the Spirit in a great while reaſcend to the height which it had when the water was cold.

The ſame Experiment, being at another time reiterated, was tried with the like ſucceſs; which ſecond may therefore ſerve for a Confirmation of the firſt.]

EXPER.

EXPER. III.

HAving a mind likewiſe to ſhew ſome Ingenious men, how much the production of Heat and Cold depends upon Texture and other Mechanical Affections, I thought fit to make again a Sal Armoniac by a way I formerly publiſh'd, that I might be ſure to know what Ingredients I employ'd, and ſhew their effects as well before conjunction as after it. I took then Spirit of Salt, and Spirit of fermented or rather putrified Urine; and having put a ſeal'd Weather-glaſs into an open Veſſel, where one of them was pour'd in, I put the other by degrees to it, and obſerv'd, that, as upon their mingling they made a great noiſe with many bubbles, ſo in this conflict they loſt their former coldneſs, and impell'd up the Spirit of Wine in the ſeal'd Thermoſcope: Then ſlowly evaporating the ſuperfluous moiſture, I obtained

tained a fine ſort of Sal Armoniac for the moſt part figur'd not unlike the other, when being diſſolv'd and filtrated, it is warily coagulated. This new Salt being gently dry'd I put into a wide Glaſs of water, wherein I had before plac'd a ſeal'd Weather-glaſs, that the included Spirit might acquire the temper of the ambient Liquor, and having ſtirr'd this Salt in the water, though I took it then off the mantle-tree of a Chimney that had had fire in it divers hours before, it did, as I expected, make the tinged Spirit haſtily ſubſide and fall conſiderably low.

EXPER. IV.

SInce if two bodies upon their mixture acquire a greater degree of Cold than either of them had before there is a production of this additional degree of that Quality, it will

will be proper to add on this occaſion the enſuing Experiment.

We took a competent quantity of acid ſpirit diſtill'd from Roch-allom, (that, though rectifi'd, was but weak,) which, in the ſpirit of that ſalt, is not ſtrange. Of this we put into a wide mouth'd Glaſs (that was not great) more than was ſufficient to cover the globulous part of a good ſeal'd Thermoſcope, and then ſuffering the inſtrument to ſtay a pretty while in the liquor, that the Spirit of wine might be cool'd as much as the ambient was, we put in little by little ſome volatile ſalt ſublimed from Sal Armoniac and a fixt *Alcali*, and notwithſtanding the very numerous (but not great) bubbles, and the noiſe and froath that were produced, as is uſual upon the reaction of Acids and Alcalys, the tincted ſpirit in the Weather-glaſs, after having continued a good while at a ſtand, began a little to deſcend, and continued (though but very ſlowly) to do ſo, till the ſpirit of Allom was glutted with

with the volatile ſalt; and this deſcent of the tincted liquor in the Inſtrument being meaſur'd, appear'd to be about an inch (for it manifeſtly exceeded ſeven eighths.) By comparing this Experiment with the firſt part of the foregoing, we may gather, that when Volatile and Urinous Salts or Spirits (for the ſaline particles appear ſometimes in a dry and ſometimes in a liquid form) tumultuate upon their being mixt with Acids, neither the Heat nor the Cold that enſues is produc'd by a Conflict with the Acids preciſely as it is Acid, ſince we have ſeen that an urinous ſpirit produc'd an actual Heat with ſpirit of Salt, and the diſtill'd Salt of Sal Armoniac, which is alſo Urinous, with the acid ſpirit of Roch-Allom produces not a true effervеſcence, but a manifeſt Coldneſs: As the ſame Salt alſo did in a Trial of another ſort, which was this.

EX-

EXPER. V.

WE took one part of Oyl of Vitriol, and ſhaking it into twelve parts of water we made a mixture, that at firſt was ſenſibly warm; then ſuffering this to cool, we put a ſufficient quantity of it into a wide mouth'd glaſs, and then we put a good Thermoſcope Hermetically ſeal'd, above whoſe Ball the compounded liquor reached a pretty way. After ſome time had been allowed that the liquor in the Thermometer might acquire the temper of the ambient; we put in by degrees as much volatile Salt of Sal Armoniac as would ſerve to ſatiate the acid ſpirits of the mixture: for, though theſe two made a notable conflict with tumult, noiſe, and froth, yet 'twas but a cold ebullition (if I may ſo ſtile it,) for the ſpirit in the Thermoſcope deſcended about an inch beneath the mark it reſted at, when the ſeeming effervescence began. EX-

EXPER. VI.

'Tis known that Salt-peter being put into common water produces a ſenſible Coldneſs in it, as it alſo does in many other Liquors: But that the ſame Salt put into a Liquor of another Conſtitution may have a quite differing effect, I have convinc'd ſome inquiſitive perſons by mingling eight ounces of fine Salt-peter powder'd with ſix ounces of Oyl of Vitriol: For by that commixture with a Salt that was not only actually, but, as to many other bodies, potentially cold, the Oyl of Vitriol, that was ſenſibly cold before, quickly conceived a conſiderable degree of Heat, whoſe Effects alſo became viſible in the copious Fumes that were emitted by the incaleſcent Mixture.

EX-

EXPER. VII.

THis brings into my mind, that *though* Gunpowder ſeems to be of ſo igneous a nature, that, when 'tis put upon a Coal, it is turn'd preſently into flame capable of promoting the deflagration of the Charcoal, and kindling divers bodies it meets with in its way; *yet* if ſome ounces of Gunpowder reduced to powder be thrown into four or five times as much water, it will very manifeſtly impart a Coldneſs to it, as experience made *with*, as well as *without*, a ſeal'd Thermoſcope has aſſured me.

This and the foregoing Experiment do readily ſuggeſt an Inquiry into the nature of the Coldneſs, which Philoſophers are wont to oppoſe to that which immediately and upon the firſt contact affect the organs of ſenſe, and which therefore they call Actual or Formal.

The

The ſucceſs of this Experiment upon a ſecond trial ſerv'd to confirm it, which is the more ſtrange, becauſe I have found, that a ſmall quantity of Oyl of Vitriol, not beforehand mingled with water, would produce a notable heat in its conflict with a ſmall portion of juſt ſuch Salt as I employed before (both the parcels having been, if I well remember, taken out of the ſame Glaſs.) And this heat did upon trial, made with the former Thermoſcope, make the tincted Spirit aſcend much further than the lately recited Experiment made it ſubſide.

A DIGRESSION ABOUT POTENTIAL COLDNESS.

Potential Coldneſs has been generally lookt upon, and that partly perhaps upon the ſcore of its very name, as ſo abſtruſe a Quality, that 'tis not onely rational but neceſſary to derive it from the *ſubſtantial Forms* of bodies. But I confeſs I ſee no neceſſity of believing it not to be referrable to Mechanical Principles. For as to the chief Inſtances of Potential Coldneſs, which are taken from the effects of ſome Medicines and aliments in the bodies of men, it may be ſaid without improbability, that the produced Refrigeration proceeds chiefly from this, that the potentially cold

cold body is made up of Corpuſcles of ſuch ſize, ſhape, &c. that being reſolved and disjoined by the Menſtruum of the ſtomach, or the fluids it may elſewhere meet with, they do ſo aſſociate themſelves with the ſmall parts of the blood and other liquors, as, by clogging them or otherwiſe, to leſſen their wonted agitation, and perhaps make them act in a peculiar way as well as leſs briskly on the nervous and fibrous parts; and the perception of this Imminution (and perhaps change) of motion in the organs of feeling is that, which, being referr'd to the body that produces it, we call its *Potential* Coldneſs. Which Quality appears by this account to be, as I was ſaying before, but a Relative thing, and is wont to require the diffuſion or diſperſion of the ſmall parts of the Corpuſcles of the Agent, and their mingling themſelves with the liquors or the ſmall parts of the body they are to refrigerate. And therefore, if it be granted, that

in Agues there is ſome morbifick matter of a viſcous or not eaſily diſſipable texture, that is harbor'd in ſome part of the body, and requires ſuch a time to be made fluid and reſolvable; the Cold Fits of Agues need not be ſo much admired as they uſually are; ſince, though juſt before the Fit the ſame parcel of matter that is to produce it were actually in the body, yet it was not by reaſon of its clammineſs actually reſolved into ſmall parts, and mingled with thoſe of the bloud, and conſequently could not make ſuch a change in the motion of that liquor as is felt in the *Cold Fit* of an Ague; (for, of the further Change that occaſions the *Hot Fit*, I am not here to ſpeak) And in ſome other Diſeaſes a ſmall quantity of matter, being reſolved into minute parts, may be able to produce a great ſenſe of Coldneſs in ſome part of a body, which by reaſon of the ſtructure of that part may be peculiarly diſpoſed to be affected thereby; as

I have known Hypochondriack and Hysterical women complain of great Degrees of Coldness, that would suddenly invade some particular part, chiefly of the Head or Back, and be for a good while troublesome there. And that, if a frigorific vapour or matter be exceeding subtile, an inconsiderable Quantity of it being dispersed through the bloud may suffice to produce a notable Refrigeration, I have learnt by Inquiry into the Effects of some Poysons; and 'tis not very material, whether the Poyson, generally speaking, be cold or hot, if it meet with a body dispos'd to have those affections that pass for cold ones produced in it. For I have made a Chymical Liquor, that was penetrant and fiery enough to the Taste, and had acquired a Subtlety and briskness from Distillation, with which I could almost in a trice, giving it but in the quantity of about a drop, cast an *Animal* into that which appear'd a sleep, and the like

Liquor, in a not much greater quantity, being, by I know not whose mistake, apply'd to the aking Tooth of a very Ingenious Person, did presently, as he soon after told me, give him an universal Refrigeration, and trembling, worse than the cold Paroxisme of a Quartane. And though Scorpions do sometimes cause, by their sting, violent Heats in the parts they hurt, yet sometimes also the quite contrary happens, and their Poyson proves, in a high degree, potentially cold; as may be learnt from the two following Observations recorded by eminent Physicians.* *Famulum habui, (saith Benivenius) qui à Scorpione ictus, tam subito ac tam frigido sudore toto corpore perfusus est, ut algentissimâ nive atque glacie sese opprimi quereretur. Verum cum algenti illi solam Theriacam ex vino potentiore exhibuissem, illicò curatus est:* Thus far he: To whose Narrative I adde this of *Amatus Lusitanus.*

* *Benivent. cap. 56. Abditorum apud Schenk. Lib. 7. de venen. Observ. 24.*

Vir

Vir qui à Scorpione in manus digito punctus fuit, multum dolebat, & refrigeratus totus contremebat, & per corpus dolores, cute totâ quaſi acu punctâ, formicantes patiebatur, &c. Cent. 6. Obſerv.

I cannot now ſtay to enquire, Whether there may not be in theſe great Refrigerations, made by ſo ſmall a quantity of Poyſon, ſome ſmall Concretions or Coagulations made of the minute particles of the bloud into little clots, leſs agile and more unwieldy than they were when they moved ſeparately: which may be illuſtrated by the little Curdlings that may be made of the parts of Milk by a very ſmall proportion of Runnet or ſome acid liquor, and the little coagulations made of the Spirit of Wine by that of Urine: Nor will I now enquire, whether, beſides the retardment of the motion of the bloud, ſome poyſons and other analogous Agents may not give the motion of it a new modification, (as if ſome Corpuſcles that uſually are

more whirl'd or brandiſh'd be put into a more direct Motion) that may give it a peculiar kind of grating or other action upon the nervous and fibrous parts of the body. Theſe, I ſay, and other ſuſpicions that have ſometimes come into my thoughts, I muſt not ſtay to examine; but ſhall now rather offer to Conſideration, Whether, ſince ſome parts of the humane body are very differing from others in their ſtructure and internal Conſtitution; and ſince alſo ſome Agents may abound in Corpuſcles of differing ſhapes, bulks, and motions, the ſame Medicine may not in reference to the ſame humane body be potentially cold or potentially hot, according as 'tis applied; or perhaps may, upon one or both of the accounts newly mentioned, be cold in reference to one part of the body, and hot in reference to the other. And theſe effects need not be always aſcrib'd to the meer and immediate action of the Corpuſcles of the Medicine, but

ſometimes to the new Quality they acquire in their Paſſage by aſſociating themſelves with the bloud or other fluids of the body, or to the expulſion of ſome calorific or frigorific Corpuſcles, or to the Diſpoſition they give the part on which they operate, to be more or leſs permeated and agitated than before by ſome ſubtile æthereal matter, or other Efficients of Heat or Cold. Some of theſe Conjectures about the Relative Nature of Potentially cold bodies, may be either confirmed or illuſtrated by ſuch Inſtances as theſe; that Spirit of Wine being inwardly taken is potentially very hot, and yet being outwardly applied to ſome Burns and ſome hot Tumours does notably abate the Heat of the inflamed parts, though the ſame Spirit applied even outwardly to a tender eye will cauſe a great and dolorous agitation in it. And Camphire, which in the Doſe of leſs than a half or perhaps a quarter of a Scruple, has been obſerved to diffuſe

fuſe a Heat through the body, is with ſucceſs externally applied by Phyſicians and Chirurgeons in refrigerating Medicines.

But I leave the further Inquiry into the Operations of Medicines to Phyſicians, who may poſſibly, by what has been ſaid, be aſſiſted to compoſe the differences between ſome famous Writers about the temperament of ſome Medicines, as Mercury, Camphire, *&c.* which ſome will have to be cold, and others maintain to be hot; and ſhall onely offer by way of confirming, in general, that Potential Coldneſs is onely a Relative Quality, a few Particulars; the firſt whereof is afforded by comparing together the VI. and the VII. Experiment before going, (which have occaſion'd this Digreſſion about Potential Coldneſs;) ſince by them it ſeems probable, that the ſame thing may have it in reference to one body, and not to another, according to the diſpoſition of the body it operates upon; or that operates

rates upon it. And the Fumes of Lead have been obſerved ſometimes (for I have not found the Effect to ſucceed always) to arreſt the fluidity of Mercury, which change is ſuppoſed to be the effect of a Potential Coldneſs belonging to the Chymiſts Saturn in reference to fluid Mercury, though it have not that operation on any other liquor that we know of.

And laſtly, (for I would not be too prolix) though Nitre and Sal Armoniac be both apart and joyntly Cold in reference to Water, and though, however Nitre be throughly melted in a Crucible, it will not take fire of it ſelf, yet if, whilſt it is in Fuſion, you ſhall by degrees caſt on it ſome powder'd Sal Armoniac, it will take fire and flaſh vehemently, almoſt as if Sulphur had been injected.

But

But our Excursion has, I fear, lasted too long, and therefore I shall presently re-enter into the way, and proceed to set down some Trials about Cold.

EX-

EXPER. VIII.

IN the *first* Experiment we obſerved, that upon the pouring of water upon Sal Armoniac there enſued an intenſe degree of Cold, and we have elſewhere recited, that the like effect was produc'd by putting, inſtead of common water, Oyl of Vitriol to Sal Armoniac; but now, to ſhew further, what influence Motion and Texture may have upon ſuch Trials, it may not be amiſs to adde the following Experiment: To twelve ounces of Sal Armoniac we put by degrees an equal weight of water, and whilſt the Liquor was diſſolving the Salt, and by that action producing a great Coldneſs, we warily pour'd in twelve ounces alſo of good Oyl of Vitriol; of which new mixture the event was, that a notable degree of Heat was quickly produced in the Glaſs wherein the Ingredients were confounded, as unlikely as it ſeemed, that, whereas each

each of the two Liquors is wont with Sal Armoniac to produce an intenſe Cold, both of them acting on it together ſhould produce the contrary Quality. But the reaſon I had to expect the ſucceſs, I met with, was this, that 'twas probable the Heat ariſing from the mixture of the two Liquors would overpower the Coldneſs produceable by the operation of either, or both, of them upon the Salt.

FINIS.

EXPER. IX.

IN moſt of the Experiments that we have hitherto propoſed, *Cold* is wont to be *regularly* produc'd in a Mechanical way; but I ſhall now adde, that in ſome ſort of Trials I found that the Event was *varied* by unobſerv'd Circumſtances; ſo that ſometimes manifeſt Coldneſs would be produced by mixing two Bodies together, which at another time would upon their Congreſs diſcloſe a manifeſt Heat, and ſometimes again, though more rarely, would have but a very faint and remiſs degree of either.

Of this ſort of Experiments, whoſe Events I could not confidently undertake for, I found to be, the diſſolution of Salt of Tartar in Spirit of Vinegar, and of ſome other Salts, that were not acid, in the ſame Menſtruum, and even Spirit of Verdigreaſe (made *per ſe*) though a more

potent Menſtruum than common Spirit of Vinegar, would not *conſtantly* produce near ſuch a heat at the beginning of its operation, as the greatneſs of the ſeeming Effervescence, then excited, would make one expect, as may appear by the following Obſervation tranſcrib'd *verbatim* out of one of my *Adverſaria*.

[Into eight ounces of Spirit of Verdigreaſe (into which we had put a while before a ſtandard-Thermoſcope to acquire the like temper with the Liquor) we put in a wide-mouthed Glaſs two ounces of Salt of Tartar, as faſt as we durſt for fear of making the matter boil over; and though there were a great commotion excited by the action and reaction of the Ingredients, which was attended with a copious froth and a hiſſing noiſe; yet 'twas a pretty while e're the Glaſs was ſenſibly warm on the outſide; but by that time the ſalt was all diſſolv'd, the Liquor in the Thermoſcope appear'd to be impell'd

pell'd up about three inches and an half.]

And yet, if my memory do not much deceive me, I have found, that by mixing Salt of Tartar with another Salt, the Texture of the fixt *Alkali* was ſo alter'd, that upon the affuſion of ſpirit of Verdigreaſe, (made without ſpirit of Vinegar and ſpirit of Wine,) though there enſued a great conflict with noiſe and bubbles, yet, inſtead of an Incaleſcence, a conſiderable degree of Coldneſs was produced.

EXPER. X.

'Tis very probable that further Trials will furniſh us with more Inſtances to ſhew how the Production of Cold may in ſome caſes be effected, varied, or hinder'd by Mechanical Circumſtances that are eaſily and uſually overlook'd. I remember, on this occaſion, that though

in the Experiment above recited we obſerv'd, that Oyl of Vitriol and water being firſt ſhaken together, the volatil ſalt of Sal Armoniac being afterwards put to them, produced a ſenſible Coldneſs; yet I found, that if a little Oyl of Vitriol and of the volatile Salt were firſt put together, though ſoon after a conſiderable proportion of water were added, there would be produc'd not a Coldneſs, but a manifeſt degree of Heat, which would impell up the liquor in the Thermoſcope to the height of ſome inches. And I remember too, that though Salt of Tartar will, as we ſhall ſee e're long, grow hot in the water, yet having diſtill'd ſome Salt of Tartar and Cinaber in a ſtrong fire, and put the whole *Caput mortuum* into diſtill'd or Rain-water, it made indeed a hiſſing there as if it had been Quick-lime, but produced no Heat, that I could by feeling perceive. I ſhall adde, that not onely, as we have ſeen already, ſome unheeded Circumſtances may promote

or

or hinder the artificial Production of Cold by particular Agents, but, which will ſeem more ſtrange, ſome unobſerv'd, and perhaps hardly obſervable, Indiſpoſition in the Patient may promote or hinder the effects of the grand and Catholick Efficients of Cold, whatever thoſe be. This ſuſpicion I repreſent as a thing that further experience may poſſibly countenance, becauſe I have ſometimes found, that the degree of the Operation of Cold has been much varied by latent Circumſtances, ſome bodies being more wrought upon, and others leſs, than was upon very probable grounds expected. And particularly I remember, that though Oyl of Vitriol be one of the fierieſt liquors that is yet known, and does perform ſome of the Operations of fire it ſelf, (as we ſhall elſewhere have occaſion to ſhew) and will thaw Ice ſooner than Spirit of Wine or any other liquor, as I have tried; yet having put about a pound or more, by our eſtimate, of choice rectified

Oyl of Vitriol into a ſtrong Glaſs-Vial proportionable to it, we found, that, except a little that was fluid at the top, it was all congeal'd or coagulated into a maſs like Ice, though the Glaſs ſtood in a Laboratory where a fire was conſtantly kept not far from it, and where Oyl of Vitriol very ſeldom or never has before or ſince been obſerv'd to congeal or coagulate ſo much as in part. And the odneſs of our *Phænomenon* was increas'd by this Circumſtance, that the Maſs continued ſolid a good while after the weather was grown too mild to have ſuch Operations upon Liquors far leſs indiſpos'd to loſe their fluidity by Cold, than even common Oyl of Vitriol is. On the other ſide I remember, that about two years ago, I expos'd ſome Oyl of ſweet Almonds hermetically ſeal'd up in a Glaſs-bubble, to obſerve what Condenſation an intenſe cold could make of it, (for though Cold expands water, it condenſes common oyl;) but the next day I found

found to my wonder, that not onely the oyl remain'd unfrozen by the ſharp froſt it had been expos'd to, but that it had not its tranſparency troubled, though 'tis known, that oyl will be brought to concrete and turn opacous by a far leſs degree of Cold than is requiſite to freeze water; notwithſtanding which this liquor, which was lodged in a glaſs ſo thin, that 'twas blown at the flame of a Lamp, continued fluid and diaphanous in very froſty weather, ſo long till I loſt the expectation of ſeeing it congeal'd or concreted. And this brings into my mind, that though Camphire be, as I formerly noted, reckon'd by many potentially cold, yet we kept ſome oyl of it, of our making, wherein the whole body of the Camphire remain'd, being onely by ſome Nitrous Spirits reduc'd to the form of an Oyl; we kept it, I ſay, in ſuch intenſe degrees of Cold, that would have eaſily frozen water, without finding it to loſe its Tranſ-

parency or its Fluidity.

And here I ſhall put an end to the firſt Section, (containing our Notes about *Cold*) the deſign of which may be not a little promoted by comparing with them the beginning of the enſuing Section. For if it be true, that (as we there ſhew) the nature of *Heat* conſiſts either onely or chiefly in the local motion of the ſmall parts of a body Mechanically modified by certain conditions, of which the principal is the vehemency of the various agitations of thoſe inſenſible parts; and if it be alſo true, as Experience witneſſes it to be, that, when the minute parts of a body are in or arrive at ſuch a ſtate, that they are more ſlowly or faintly agitated than thoſe of our fingers or other organs of feeling, we judge them cold: Theſe two things laid together ſeem plainly enough to argue, that a Privation or Negation of that Local Motion that is requiſite to conſtitute Heat, may ſuffice for the denominating a body Cold, as Coldneſs

neſs is a quality of the Object, (which as 'tis perceiv'd by the mind, is alſo an affection of the Sentient:) And therefore an Imminution of ſuch a degree of former motion as is neceſſary to make a body Hot as to ſenſe, and which is ſufficient to the Production of ſenſible Coldneſs, may be Mechanically made, ſince Slowneſs as well as Swiftneſs being a Mode of Local motion is a Mechanical thing: And though its effect, which is Coldneſs, ſeem a Privation or Negation; yet the Cauſe of it may be a poſitive Agent acting Mechanically, by clogging the Agile Calorific Particles, or deadning their motion, or perverting their determination, or by ſome other intelligible way bringing them to a ſtate of Coldneſs as to ſenſe: I ſay Coldneſs as to ſenſe; becauſe as 'tis a Tactile Quality, in the popular acception of it, 'tis relative to our Organs of Feeling; as we ſee that the ſame luke-warm water will appear hot and cold to the ſame mans hands, if, when

when both are plung'd into it, one of them ſhall have been newly held to the fire, and the other be benummed with froſt. And indeed the cuſtom of ſpeaking has introduced an ambiguity into the word *Cold*, which often occaſions miſtakes, not eaſily without much attention and ſometimes circumlocution alſo to be avoided; ſince uſually by Cold is meant that which immediately affects the ſenſory of him that pronounces a body Cold, whereas ſometimes 'tis taken in a more general notion for ſuch a Negation or Imminution of motion, as though it operates not perceivably on our ſenſes, does yet upon other bodies; and ſometimes alſo it is taken (which is perhaps the more Philoſophical ſenſe) for a perception, made in and by the mind, of the alteration produced in the Corporeal Organs by the operation of that, whatever it be, on whoſe account a body is found to be cold.

But

But the Diſcuſſion of theſe Points is here purpoſely omitted, as for other Reaſons, ſo principally becauſe they may be found expreſly handled in a fitter place.

SECT.

SECT. II.

Of the Mechanicall Origine or Production of HEAT.

AFter having diſpatched the Inſtances I had to offer of the Production of Cold, it remains that I alſo propoſe ſome Experiments of *Heat*, which Quality will appear the more likely to be Mechanically producible, if we conſider the nature of it, which ſeems to conſiſt mainly, if not onely, in that Mechanical affection of matter we call Local motion mechanically modified, which modification, as far as I have obſerved, is made up of three Conditions.

The firſt of theſe is, that the agitation of the parts be *vehement*, by which degree or rapidneſs, the motion proper to bodies that are hot diſtin-

diſtinguiſhes them from bodies that are barely *fluid*. For theſe, as ſuch, require not near ſo brisk an agitation, as is wont to be neceſſary to make bodies deſerve the name of *hot*. Thus we ſee that the particles of water in its natural (or uſual) ſtate, move ſo calmly, that we do not feel it at all warm, though it could not be a liquor unleſs they were in a reſtleſs motion; but when water comes to be actually hot, the motion does manifeſtly and proportionably appear more vehement, ſince it does not onely briskly ſtrike our organs of feeling, but ordinarily produces ſtore of very ſmall bubbles, and will melt butter or coagulated oyl, caſt upon it, and will afford vapours, that, by the agitation they ſuffer, will be made to aſcend into the air. And if the degree of Heat be ſuch as to make the water boil, then the agitation becomes much more manifeſt by the confus'd motions, and waves, and noiſe, and bubbles, that are excited, and by other obvious

obvious effects and Phænomena of the vehement and tumultuous motion, which is able to throw up visibly into the air great store of Corpuscles, in the form of vapours or smoak. Thus in a heated Iron the vehement agitation of the parts may be easily inferr'd from the motion and hissing noise it imparts to drops of water or spittle that fall upon it. For it makes them hiss and boil, and quickly forces their particles to quit the form of a liquor, and flye into the air in the form of steams. And lastly, Fire, which is the hottest body we know, consists of parts so vehemently agitated, that they perpetually and swiftly flye abroad in swarms, and dissipate or shatter all the combustible bodies they meet with in their way; fire making so fierce a dissolution, and great a dispersion of its own fuel, that we may see whole piles of solid wood (weighing perhaps many hundred pounds) so dissipated in very few hours into flame and smoak, that oftentimes

tentimes there will not be one pound of Aſhes remaining. And this is the firſt Condition required to Heat.

The ſecond is this, that the *determinations be very various*, ſome particles moving towards the right, ſome to the left, hand, ſome directly upwards, ſome downwards, and ſome obliquely, &c. This variety of determinations appears to be in hot bodies both by ſome of the Inſtances newly mention'd, and eſpecially that of flame, which is a body; and by the diffuſion that metals acquire, when they are melted, and by the operations of Heat that are exercis'd by hot bodies upon others, in what poſture or ſcituation ſoever the body to be heated be applied to them. As a thoroughly ignited Coal will appear every way red, and will melt wax, and kindle brimſtone, whether the body be apply'd to the upper or to the lower, or to any other part of the burning Coal. And congruouſly to this Notion, though

air

air and water be mov'd never so vehemently, as in high Winds and Cataracts, yet we are not to expect that they ſhould be manifeſtly hot, becauſe the vehemency belongs to the progreſſive motion of the whole body; notwithſtanding which, the parts it conſiſts of may not be near ſo much quickned in their motions made according to other determinations, as to become ſenſibly hot. And this Conſideration may keep it from ſeeming ſtrange, that in ſome caſes, where the whole body, though rapidly moved, tends but one way, 'tis not by that ſwift motion perceived to be made Hot.

Nay, though the agitation be very *various* as well as *vehement*, there is yet a third Condition required to make it Calorific, namely, that the agitated particles, or at leaſt the greateſt number of them, be ſo minute as to be ſingly *inſenſible*. For though a heap of ſand or duſt it ſelf were vehemently and confuſedly agitated by a whirlwind, the bulk of the

the grains or Corpuſcles, would keep their agitation from being properly Heat, though by their numerous ſtrokes upon a man's face, and the brisk commotion of the ſpirits and other ſmall particles that may thence enſue, they may perchance occaſion the production of that Quality.

If ſome attention be employ'd in conſidering the formerly propos'd Notion of the nature of Heat, it may not be difficult to diſcern, that the Mechanical production of it may be divers ways effected. For, excepting in ſome few Anomalous caſes, (wherein the regular courſe of things happens to be over-rul'd,) by whatever ways the *Inſenſible parts* of a body are put into a very *confus'd* and *vehement agitation*, by the ſame ways Heat may be introduc'd into that body: agreeably to which Doctrine, as there are ſeveral Agents and Operations by which this Calorific Motion (if I may ſo call it) may be excited, ſo there may be ſeveral ways of Mechanically producing

Heat, and many Experiments may be reduc'd to almoſt each of them, chance it ſelf having in the Laboratories of Chymiſts afforded divers *Phænomena* referrable to one or other of thoſe Heads. Many of the more familiar Inſtances, applicable to our preſent purpoſe, have been long ſince collected by our juſtly famous *Verulam* in his ſhort, but excellent, Paper *de forma calidi*, wherein (though I do not acquieſce in every thing I meet with there) he ſeems to have been, at leaſt among the Moderns, the Perſon that has firſt handled the Doctrine of *Heat* like an Experimentall Philoſopher. I ſhall therefore decline accumulating a multitude of Inſtances of the Production of Heat, and I ſhall alſo forbear to inſiſt on ſuch known things, as the Incaleſcence obſervable upon the pouring either of Oyl of Vitriol upon Salt of Tartar, (in the making of *Tartarum Vitriolatum*) or of *Aqua fortis* upon Silver or Quickſilver, (in the diſſolution of theſe Metals) but

ſhall

ſhall rather chuſe to mention ſome few Inſtances not ſo notorious as the former, but not unfit by their variety to exemplifie ſeveral of the differing ways of exciting Heat.

And yet I ſhall not decline the mention of the moſt obvious and familiar Inſtance of all, namely the Heat obſerved in Quick-lime upon the affuſion of cold water, becauſe among learned men, and eſpecially Peripateticks, I find cauſes to be aſſign'd that are either juſtly queſtionable or manifeſtly erroneous. For as to what is inculcated by the Schools about the Incaleſcence of a mixture of Quick-lime and water by vertue of a ſuppoſed *antiperiſtaſis* or Invigoration of the internal Heat of the Lime by its being inviroued by cold water, I have elſewhere ſhewn, that this is but an Imaginary Cauſe, by delivering upon Experiment (which any man may eaſily make) that, if inſtead of cold water the liquor be poured on very hot, the ebullition of the Lime will not be the

leſs, but rather the greater: And Oyl of Turpentine, which is a lighter, and is lookt upon as a ſubtiler liquor than water, though it be poured quite cold on Quick-lime, will not, that I have obſerved, grow ſo much as ſenſibly hot with it.

And now I have mentioned the Incaleſcence of Lime, which, though an obvious *Phænomenon*, has exerciſed the wits of divers Philoſophers and Chymiſts, I will adde two or three Obſervations in order to an Inquiry that may be ſome other time made into the genuine Cauſes of it; which are not ſo eaſie to be found as many learned men may at firſt ſight imagine. The acute *Helmont* indeed and his followers have ingeniouſly enough attempted to derive the Heat under conſideration from the conflict of ſome Alcalizate and Acid ſalts, that are to be found in Quick-lime, and are diſſolved, and ſo ſet at liberty to fight with one another by the water that ſlakes the Lime. But though we have ſome manifeſt marks of

of an Alcalizate Salt in Lime, yet that it contains also an Acid Salt, has not, that I remember, been proved; and if the emerging of Heat be a sufficient reason to prove a latent acid Salt in Lime, I know not, why I may not inferr, that the like Salt lies conceal'd in other bodies, which the Chymists take to be of the purest or meerest sort of *Alcalys*.

For I have purposely *EXPER. I.* tried, that by putting a pretty quantity of dry Salt of Tartar in the palm of my hand, and wetting it well in cold water, there has been a very sensible Heat produced in the mixture; and when I have made the trial with a more considerable quantity of salt and water in a Viol, the heat proved troublesomely intense, and continued to be at least sensible a good while after.

This Experiment seems to favour the opinion, that the Heat produced in Lime whilst 'tis quenching, proceeds from the *Empyreuma*, as the Chymists call it, or impression left

by the violent fire, that was employ'd to reduce the ſtone to Lime. But if by *Empyreuma* be meant a bare impreſſion made by the fire, 'twill be more requiſite than eaſie, to declare intelligibly, in what that impreſſion conſiſts, and how it operates to produce ſuch conſiderable effects. And if the effect be aſcribed to ſwarms of Atomes of fire, that remain adherent to the ſubſtance of the Lime, and are ſet at liberty to flye away by the liquor, which ſeems to be argued by the ſlaking of Lime without water, if it be for ſome time left in the air, whereby the Atomes of fire get opportunity to flye away by little and little: If this, I ſay, be alledged, I will not deny but there may be a ſenſe, (which I cannot explicate in few words) wherein the Cooperation of a ſubſtantial *Effluvium*, for ſo I call it, of the fire, may be admitted in giving an account of our *Phænomenon*. But the Cauſe formerly aſſigned, as 'tis crudely propoſed, leaves in my mind ſome

ſome Scruples. For 'tis not ſo eaſie to apprehend, that ſuch light and minute bodies as thoſe of fire are ſuppoſed, ſhould be ſo long detained as by this Hypotheſis they muſt be allowed to be, in Quick-lime, kept in well-ſtopt veſſels, from getting out of ſo laxe and porous a body as Lime, eſpecially ſince we ſee not a great Incaleſcence or Ebullition enſue upon the pouring of water upon *Minium*, or *Crocus Martis per ſe*, though they have been calcined by violent and laſting fires, whoſe Effluviums or Emanations appear to adhere to them by the increaſe of weight, that Lead, if not alſo *Mars*, does manifeſtly receive from the Operation of the Fire. To which I ſhall adde, that, whereas one would think that the igneous Atoms ſhould either flye away, or be extinguiſhed by the ſupervening of water, I know, and elſewhere give account, of an *EXPER. II.* Experiment, in which two Liquors, whereof one was furniſhed

nished me by Nature, did by being several times separated and reconjoyned without additament, at each congress produce a sensible Heat.

EXPER. III. And an Instance of this kind, though not so odd, I purposely sought and found in Salt of Tartar, from which, after it had been once heated by the affusion of water, we abstracted or evaporated the Liquor without violence of fire, till the Salt was again dry; and then putting on water a second time, the same Salt grew hot again in the Vial, and, if I misremember not, it produced this Incalescence the third time, if not the fourth; and might probably have done it oftner, if I had had occasion to prosecute the Experiment. Which seems at least to argue, that the great violence of fire is not necessary to impress what passes for an *Empyreum* upon all calcined bodies that will heat with water.

And

And on this occasion I shall venture to adde, that I have sometimes doubted, whether the Incalescence may not much depend upon the particular Disposition of the calcined body, which being deprived of its former moisture, and made more porous by the fire, doth by the help of those igneous Effluviums, for the most part of a saline nature, that are dispersed through it, and adhere to it, acquire such a Texture, that the water impell'd by its own weight, and the pressure of the Atmosphere, is able to get into a multitude of its pores at once, and suddenly dissolve the Igneous and Alcalizate Salt it every where meets with there, and briskly disjoyn the earthy and solid particles, that were blended with them; which being exceeding numerous, though each of them perhaps be very minute, and moves but a very little way, yet their multitude makes the confused agitation of the whole aggregate of them, and of the particles of the water and salt vehement

ment enough to produce a ſenſible Heat; eſpecially if we admit, that there is ſuch a change made in the Pores, as occaſions a great increaſe of this agitation, by the ingreſs and action of ſome ſubtile ethereal matter, from which alone *Monſieur des Cartes* ingeniouſly attempts to derive the Incaleſcence of Lime and water, as well as that of metals diſſolved in corroſive Liquors; though as to the *Phænomena* we have been conſidering, there ſeems at leaſt to concur a peculiar diſpoſition of body, wherein Heat is to be produced to do one or both of theſe two things, namely, to retain good ſtore of the igneous *Effluvia*, and to be, by their adheſion or ſome other operation of the fire, reduced to ſuch a Texture of its component Particles, as to be fit to have them eaſily penetrated, and briskly as well as copiouſly diſſipated, by invading water. And this Conjecture (for I propoſe it as no other) ſeems favour'd by divers *Phænomena*, ſome whereof I ſhall now

now annex. For here it may be obſerved, that both the diſſolved Salt of Tartar lately mentioned, and the artificial Liquor that grows hot with the natural, reacquires that Diſpoſition to Incaleſcence upon a bare Conſtipation or cloſer Texture of the parts from the ſuperfluous moiſture they were drowned in before: The Heat that brought them to this Texture having been ſo gentle, that 'tis no way likely that the igneous Exhalations could themſelves produce ſuch a Heat, or at leaſt that they ſhould adhere in ſuch numbers as muſt be requiſite to ſuch an effect, unleſs the Texture of the Salt of Tartar (or other body) did peculiarly diſpoſe it to detain them; ſince I have found by Trial,

that Sal Armoniac diſ- *EXPER. IV.*
ſolv'd in water, though
boiled up with a briſker fire to a dry ſalt, would, upon its being again diſſolved in water, not produce any Heat, but a very conſiderable degree of Cold. I ſhall adde, that though

though one would expect a great Cognation between the particles of Fire adhering to Quick-Lime, and those of high rectified Spirit of Wine, which is of so igneous a nature, as to be totally inflammable; yet I have not found, that the affusion of Alkaol of Wine upon Quick-Lime, would produce any sensible Incalescence, or any visible dissolution or dissipation of the Lime, as common water would have done, though it seemed to be greedily enough soaked in by the lumps of Lime. And I further tried, that, if on this Lime so drenched I poured cold water, there insued no manifest Heat, nor did I so much as find the lump swelled, and thereby broken, till some hours after; which seems to argue, that the Texture of the Lime was such, as to admit the particles of the Spirit of Wine into some of its pores, which were either larger or more congruous, without admitting it into the most numerous ones, whereinto the Liquor must

must be received, to be able ſuddenly to diſſipate the Corpuſcles of Lime into their minuter particles, into which (Corpuſcles) it ſeems that the change that the aqueous particles received by aſſociating with the ſpirituous ones, made them far leſs fit to penetrate and move briskly there, than if they had enter'd alone.

I made alſo an Experiment that ſeems to favour our Conjecture, by ſhewing how much the Diſpoſition of Lime to Incaleſcence may depend upon an idoneous Texture, and the Experiment, as I find it regiſtred in one of my Memorials, is this.

EXPER. V.

[UPon Quick-lime we put in a Retort as much moderately ſtrong Spirit of Wine as would drench it, and ſwim a pretty way above it; and then diſtilling with a gentle

gentle fire, we drew off ſome Spirit of Wine much ſtronger than that which had been put on, and then the Phlegm following it, the fire was increas'd, which brought over a good deal of phlegmatic ſtrengthleſs Liquor; by which one would have thought that the Quick-lime had been ſlaked; but when the remaining matter had been taken out of the Retort, and ſuffer'd to cool, it appear'd to have a fiery diſpoſition that it had not before. For if any lump of it as big as a Nutmeg or an Almond was caſt into the water, it would hiſs as if a coal of fire had been plunged into the Liquor, which was ſoon thereby ſenſibly heated. Nay, having kept divers lumps of this prepared *Calx* well cover'd from the air for divers weeks, to try whether it would retain this property, I found, as I expected, that the *Calx* operated after the ſame manner, if not more powerfully. For ſometimes, eſpecially when 'twas reduced to ſmall pieces, it would upon its

its coming into the water make ſuch a brisk noiſe, as might almoſt paſs for a kind of Exploſion.]

Theſe *Phænomena* ſeem to argue, that the Diſpoſition that Lime has to grow hot with water, depends much on ſome peculiar Texture, ſince the aqueous parts, that one would think capable of quenching all or moſt of the Atomes of Fire that are ſuppoſed to adhere to Quick-lime, did not near ſo much weaken the diſpoſition of it to Incaleſcence, as the acceſſion of the ſpirituous Corpuſcles and their Contexture, with thoſe of the Lime, increaſed that igneous Diſpoſition. And that there might intervene ſuch an aſſociation, ſeems to me the more probable, not onely becauſe much of the diſtill'd Liquor was as phlegmatick, as if it had been robb'd of its more active parts, but becauſe I have ſometimes had Spirit of Wine come over with Quick-lime not in unobſerved ſteams, but white fumes. To which I ſhall adde, that, beſides that the Taſte, and perhaps

Odour

Odour of the Spirit of Wine, is often manifeſtly changed by a well-made Diſtillation from Quick-lime; I have ſometimes found that Liquor to give the Lime a kind of Alcalizat penetrancy, not to ſay fierineſs of Taſte, that was very brisk and remarkable. But I will not undertake, that every Experimenter, nor I my ſelf, ſhall always make trials of this kind with the ſame ſucceſs that I had in thoſe above recited, in regard that I have found Quick-limes to differ much, not onely according to the degree of their Calcination, and to their Recentneſs, but alſo, and that eſpecially, according to the differing natures of the ſtones and other bodies calcined. Which Obſervation engages me the more to propoſe what hath been hitherto deliver'd about Quick-lime, as onely Narratives and a Conjecture; which I now perceive has detain'd uſo long, that I am oblig'd to haſten to the remaining Experiments, and to be the more ſuccinct in delivering them.

EX-

EXPER. VI.

AND it will be convenient to begin with an instance or two of the Production of Heat, wherein there appears not to intervene any thing in the part of the Agent or Patient but Local Motion, and the natural Effects of it. And as to this sort of Experiments, a little attention and reflection may make some familiar *Phænomenon* apposite to our present purpose. When, for example, a Smith does hastily hammer a Nail or such like piece of iron, the hammer'd metal will grow exceeding hot, and yet there appears not any thing to make it so, save the forcible motion of the hammer which impresses a vehement and variously determin'd agitation of the small parts of the Iron; which being a cold body before, by that superinduc'd commotion of its small parts, becomes in divers senses hot; first in a

more *lax acceptation* of the word in reference to some other bodies, in respect of whom 'twas cold before, and then *sensibly hot*; because this newly gain'd agitation surpasses that of the parts of our fingers. And in this Instance 'tis not to be overlookt, that oftentimes neither the hammer, *by* which, nor the anvil, *on* which a *cold piece of Iron* is forged, (for all iron does not require precedent ignition to make it obey the hammer) continue cold, after the operation is ended; which shews, that the Heat acquir'd by the forged piece of iron was not communicated by the Hammer or Anvil as Heat, but produc'd in it by motion, which was great enough to put so small a body as the piece of iron into a strong and confus'd motion of its parts without being able to have the like operation upon so much greater masses of metal, as the Hammer and the Anvil; though if the percussions were often and nimbly renewed, and the Hammer were but small,

this alſo might be heated, (though not ſo ſoon nor ſo much as the iron;) by which one may alſo take notice, that 'tis not neceſſary, a body ſhould be it ſelf hot, to be calorific. And now I ſpeak of ſtriking an iron with a Hammer, I am put in mind of an Obſervation that *ſeems* to contradict, but does *indeed* confirm, our Theory: Namely, that, if a ſomewhat large nail be driven by a hammer into a plank or piece of wood, it will receive divers ſtrokes on the head before it grow hot; but when 'tis driven to the head, ſo that it can go no further, a few ſtrokes will ſuffice to give it a conſiderable Heat; for whilſt, at every blow of the hammer, the nail enters further and further into the wood, the motion that is produc'd is chiefly progreſſive, and is of the whole nail tending one way; whereas, when that motion is ſtopt, then the impulſe given by the ſtroke being unable either to drive the nail further on, or deſtroy its intireneſs, muſt be ſpent in making a

various vehement and inteſtine commotion of the parts among themſelves, and in ſuch an one we formerly obſerv'd the nature of Heat to conſiſt.

EXPER. VII.

IN the foregoing Experiment the brisk agitation of the parts of a heated iron was made ſenſible to the *touch*; I ſhall now adde one of the attempts, that I remember I made to render it diſcoverable to the *eye* it ſelf. In order to this, and that I might alſo ſhew, that not onely a ſenſible but an intenſe degree of heat may be produc'd in a piece of cold iron by Local Motion, I caus'd a bar of that metal to be nimbly hammer'd by two or three luſty men accuſtom'd to manage that Inſtrument; and theſe ſtriking with as much force, and as little intermiſſion as they could upon the iron, ſoon brought it to that degree of Heat, that

that not onely 'twas a great deal too hot to be ſafely touched, but probably would, according to my deſign, have kindled Gunpowder, if that which I was fain to make uſe of had been of the beſt ſort: For, to the wonder of the by-ſtanders, the iron kindled the Sulphur of many of the grains of the corns of powder, and made them turn blue, though I do not well remember, that it made any of them go off.

EXPER. VIII.

BEſides the effects of manifeſt and violent Percuſſions, ſuch as thoſe we have been taking notice of to be made with a hammer, there are among *Phænomena* obvious enough, ſome that ſhew the Producibleneſs of Heat even in cold iron, by cauſing an inteſtine commotion of its parts: For we find, that, if a piece of iron of a convenient ſhape and bulk be nimbly filed with a large rough File,

a conſiderable degree of Heat will be quickly excited in thoſe parts of the Iron where the File paſſes to and fro, the many prominent parts of the Inſtrument giving a multitude of ſtrokes or puſhes to the parts of the iron that happen to ſtand in their way, and thereby making them put the neighbouring parts into a brisk and confus'd motion, and ſo into a ſtate of Heat. Nor can it be well objected, that upon this account the File it ſelf ought to grow as hot as the iron, which yet it will not do; ſince, to omit other anſwers, the whole body of the File being moved to and fro, the ſame parts, that touch the iron this moment, paſs off the next, and beſides have leaſure to cool themſelves by communicating their newly received Agitation to the air before they are brought to grate again upon the iron, which, being ſuppoſed to be held immoveable, receives almoſt perpetual ſhakes in the ſame place.

We find also, that Attrition, if it be any thing vehement, is wont to produce Heat in the solidest bodies; as when the blade of a Knife being nimbly whetted grows presently hot. And if having taken a brass Nail, and driven it as far as you can to the end of the stick, to keep it fast and gain a handle, you then strongly rub the head to and fro against the floor or a plank of wood, you may quickly find it to have acquired a Heat intense enough to offend, if not burn ones fingers. And I remember, that going once in exceeding hot weather in a Coach, which for certain reasons we caus'd to be driven very fast, the attrition of the Nave of the Wheel against the Axel-tree was so vehement as oblig'd us to light out of the Coach to seek for water, to cool the over-chafed parts, and stop the growing mischief the excessive Heat had begun to do.

The vulgar Experiment of striking fire with a Flint and Steel sufficiently declares, what a heat in a trice

may be produc'd in cold bodies by Percuſſion, or Colliſion; the later of which ſeems but mutual Percuſſion. But Inſtances of the ſame ſort with the reſt mention'd in this VI. Experiment being obvious enough, I ſhall forbear to multiply and inſiſt on them.

EXPER. IX.

FOr the ſake of thoſe that think the Attrition of contiguous air is neceſſary to the Production of manifeſt Heat, I thought among other things of the following Experiment, and made Trial of it.

We took ſome hard black Pitch, and having in a Baſon, Poringer, or ſome ſuch Veſſel, placed it a convenient diſtance under water, we caſt on it with a good Burning-glaſs the Sun-beams in ſuch a manner, that notwithſtanding the Refraction that they ſuffer'd in the paſſage through the

the interposed water, the *Focus* fell upon the Pitch, wherein it would produce sometimes bubbles, sometimes smoak, and quickly communicated a degree of Heat capable to make Pitch melt, if not also to boil.

EXPER. X.

THough the first and second Experiments of Section I. shew, that a considerable degree of Cold is produc'd by the dissolution of Sal Armoniac in common water; yet by an additament, though but single, the Texture of it may be so alter'd, that, instead of Cold, a notable degree of Heat will be produced, if it be dissolved in that Liquor. For the manifestation of which we devis'd the following Experiment.

We took Quick-lime, and slaked it in common cold water, that all the igneous or other particles, to which its power of heating that Liquor

quor is aſcrib'd, might be extracted and imbib'd, and ſo the *Calx* freed from them; then on the remaining powder freſh water was often poured, that all adhering reliques of Salt might be waſh'd off. After this, the thus dulcified *Calx*, being again well dried, was mingled with an equal weight of powder'd Sal Armoniac, and having with a ſtrong fire melted the maſs, the mixture was poured out; and being afterwards beaten to powder, having given it a competent time to grow cold, we put two or three ounces of it into a wide-mouthed Glaſs, and pouring water upon it, within about a minute of an hour the mixture grew warm, and quickly attain'd ſo intenſe a Heat, that I could not hold the Glaſs in my hand. And though this Heat did not long laſt at the ſame height, it continued to be very ſenſible for a conſiderable time after.

EX-

EXPER. XI.

TO confirm this Experiment by a notable variation; we took finely powder'd Sal Armoniac, and filings or ſcales of Steel, and when they were very diligently mixt (for that Circumſtance ought to be obſerv'd) we caus'd them to be gradually ſublim'd in a glaſs veſſel, giving a ſmart fire towards the latter end. By this Operation ſo little of the mixture aſcended, that, as we deſired, far the greateſt part of the Sal Armoniac ſtaid at the bottom with the metal; then taking out the *Caput mortuum*, I gave it time throughly to cool, but in a Glaſs well ſtopt, that it might not imbibe the moiſture of the Air, (as it is very apt to do.) And laſtly, though the Filings of Steel, as well as the Sal Armoniac, were bodies actually cold, and ſo might be thought likely to increaſe, not check,

check, the coldneſs wont to be produced in water by that Salt; yet putting the mixture into common water, there enſued, as we expected, an intenſe degree of Heat. And I remember, that having ſublim'd the forementioned Salt in diſtinct Veſſels, with the Filings of Steel, and with Filings of Copper, and for curioſities ſake kept one of the *Caput mortuums* (for I cannot certainly call to mind which of the two it was,) divers moneths, (if I miſtake not, eight or nine,) we at length took it out of the Veſſel, wherein it had been kept carefully ſtopt, and, upon trial, were not deceiv'd in having expected, that all that while the diſpoſition to give cold water a notable degree of Heat was preſerved in it.

EX-

EXPER. XII.

IF Experiments were made after the above recited manner with Sal Armoniac and other mineral bodies than Iron and Copper, 'tis not improbable, that ſome of the emerging *Phænomena* would be found to confirm what has been ſaid of the Intereſt of Texture, (and ſome few other Mechanical Affections) in the Production of *Heat* and *Cold*. Which Conjecture is ſomewhat favoured by the following Trial. Three ounces of Antimony, and an equal weight of Sal Armoniac being diligently powder'd and mixt, were by degrees of fire ſublimed in a Glaſs-veſſel, by which Operation we obtain'd three differing Subſtances, which we cauſed to be ſeparately powder'd, when they were taken out of the Subliming Glaſs, leſt the air or time ſhould make any change in them; and having before put the ball of a good

good ſeal'd Weather-glaſs for a while into water, that the Spirit of Wine might be brought to the temper of the external Liquor, we put on a convenient quantity of the powder'd *Caput mortuum*, which amounted to two ounces, and ſeemed to be little other than Antimony, which accordingly did ſcarce ſenſibly raiſe the Spirit of Wine in the Thermoſcope, though that were a tender one. Then laying aſide that water, and putting the Inſtrument into freſh, of the ſame temper, we put to it a very yellow Sublimate, that aſcended higher than the other parts, and ſeemed to conſiſt of the more ſulphureous flowers of the Antimony, with a mixture of the more volatile parts of the Sal Armoniac. And this Subſtance made the tinged Spirit in the Thermoſcope deſcend very ſlowly about a quarter of an inch; but when the Inſtrument was put into freſh water of the ſame temper, and we had put in ſome of the powder of the lower ſort of Sublimate,

limate, which was dark coloured, though both the Antimony and Sal Armoniac, it conſiſted of, had been long expoſed to the action of a Subliming Heat; yet the water was thereby ſpeedily and notably cooled, inſomuch, that the Spirit of Wine in the Weather-glaſs haſtily deſcended, and continued to ſink, till by our gueſs it had fallen not much ſhort of three inches. Of theſe *Phænomena* the Etiology, as ſome Moderns call the Theory, which propoſes the Cauſes of things, is more eaſie to be found by a little conſideration, than to be made out in few words.

We made alſo an Experiment like that above recited, by ſubliming three ounces a piece of Minium and Sal Armoniac; in which Trial we found, that though in the *Caput mortuum*, the Salt had notably wrought upon the *Calx* of Lead, and was in part aſſociated with it, as appear'd by the whiteneſs of the ſaid *Caput mortuum*, by its ſweetiſh Taſte, and by

by the weight (which exceeded four drams that of all the *Minium*;) yet a convenient quantity of this powder'd mixture being put into water, wherein the former Weather-glaſs had been kept a while, the tincted Spirit of Wine was not manifeſtly either raiſed or depreſt. And when in another Glaſs we proſecuted the Trial with the Sal Armoniac that had been ſublimed from the *Minium*, it did indeed make the Spirit of Wine deſcend, but ſcarce a quarter ſo much as it had been made to fall by the lately mention'd Sublimate of Sal Armoniac and Antimony.

EXPER. XIII.

'Tis known that many learned men, beſides ſeveral Chymical Writers, aſcribe the Incaleſcences, that are met with in the diſſolution of Metals, to a conflict ariſing from a certain Antipathy or Hoſtility, which they ſuppoſe between the conflicting bodies, and particularly between the Acid Salt of the one, and the Alcalizate Salt, whether fixt or volatile, of the other. But ſince this Doctrine ſuppoſes a hatred between Inanimate bodies, in which 'tis hard to conceive, how there can be any true paſſions, and does not intelligibly declare, by what means their ſuppos'd Hoſtility produces Heat; 'tis not likely, that, for theſe and ſome other Reaſons, Inquiſitive Naturaliſts will eaſily acquieſce in it. And on the other ſide it may be conſider'd, whether it be not more probable, that Heats, ſuddenly produ-

ced in mixtures, proceed *either* from a very quick and copious diffusion of the parts of one body through those of another, whereby both are confusedly tumbled and put into a calorific motion; *or* from this, that the parts of the dissolved body come to be every way in great numbers violently scatter'd; *or* from the fierce and confused shocks or justlings of the Corpuscles of the conflicting bodies, or masses which may be suppos'd to have the motions of their parts differingly modified according to their respective Natures: *Or* from this, that by the plentiful ingress of the Corpuscles of the one into the almost commensurate parts of the other, the motion of some etherial matter that was wont before swiftly to permeate the distinct bodies, comes to be check'd and disturbed, and forced to either brandish or whirl about the parts in a confus'd manner, till it have settled it self a free passage through the new mixture, almost as the Light does thorow di-

vers

vers troubled liquors and vitrified bodies, which at length it makes transparent. But without *here* engaging in a ſolemn examination of the *Hypotheſis* of *Alcali* and *Acidum*, and without determining whether any one, or more of the newly mention'd Mechanical Cauſes, or whether ſome other, that I have not yet named, is to be entitled to the effect; it will not be impertinent to propoſe divers Inſtances of the Production of Heat by the Operation of one Agent, *Oyl of Vitriol*, that it may be conſider'd whether it be likely, that this ſingle Agent ſhould upon the ſcore of Antipathy, or that of its being an Acid Menſtruum, be able to produce an intenſe Heat in many bodies of ſo differing natures as are ſome of thoſe that we ſhall have occaſion to name. And now I proceed to the Experiments themſelves.

Take ſome ounces of ſtrong Oyl of Vitriol, and ſhaking it with three or four times its weight of common water, though both the liquors were cold when they were put together, yet their mixture will in a trice grow intenſely hot, and continue conſiderably ſo for a good while. In this caſe it cannot probably be pretended by the Chymiſts, that the Heat ariſes from the conflict of the Acid and Alcalizate Salts abounding in the two liquors, ſince the common water is ſuppos'd an elementary body devoid of all ſalts; and at leaſt, being an inſipid liquor, 'twill ſcarce be thought to have *Alcali* enough to produce by its Reaction ſo intenſe a Heat. That the Heat emergent upon ſuch a mixture may be very great, when the Quantities of the mingled liquors are conſiderably ſo, may be eaſily concluded from one of my Memorials, wherein I find that no more than two ounces of Oyl of Vitriol being poured (but not all at once) into four ounces onely of diſtilled

ſtilled Rain-water, made and kept it manifeſtly warm for a pretty deal above an hour, and during no ſmall part of that time, kept it ſo hot, that 'twas troubleſome to be handled.

EXPER. XIV.

THe former Experiment brings into my mind one that I mention without teaching it in the Hiſtory of Cold, and it appear'd very ſurprizing to thoſe that knew not the ground of it. For having ſometimes merrily propos'd to heat cold liquors with Ice, the undertaking ſeem'd extravagant if not impoſſible, but was eaſily perform'd by taking out of a baſon of cold water, wherein divers fragments of Ice were ſwimming, one or two pieces that I perceived were well drenched with the liquor, and immerſing them ſuddenly into a wide-mouth'd Glaſs wherein ſtrong Oyl of Vitriol had

been put; for this Menſtruum, preſently mingling with the water that adher'd to the ice, produc'd in it a brisk heat, and that ſometimes with a manifeſt ſmoke, which nimbly diſſolved the contiguous parts of Ice, and thoſe the next, and ſo the whole Ice being ſpeedily reduced to water, and the corroſive Menſtruum being by two or three ſhakes well diſperſed through it, and mingled with it, the whole mixture would grow in a trice ſo hot, that ſometimes the Vial that contain'd it, was not to be endured in ones hand.

EX-

EXPER. XV.

NOtwithſtanding the vaſt difference betwixt common water and high rectified Spirit of Wine, whereof men generally take the former for the moſt contrary body to fire, and whereof the Chymiſts take the later to be but a kind of liquid Sulphur, ſince it may preſently be all reduc'd into flame; yet, as I expected, I found upon trial, that Oyl of Vitriol being mingled with pure Spirit of Wine, would as well grow hot, as with common water. Nor does this Experiment always require great quantities of the liquors. For when I took but one ounce of ſtrong Oyl of Vitriol, though I put to it leſs than half an ounce of choice Spirit of Wine, yet thoſe two being lightly ſhaken together, did in a trice conceive ſo brisk a Heat, that they almoſt fill'd the vial with fumes, and made it ſo hot, thar I had una-

wares like to have burnt my hand with it before I could lay it aside.

I made the like Trial with the same Corrosive Menstruum, and common *Aqua vitæ* bought at a Strong-water-shop, by the mixture of which Liquors, Heat was produc'd in the Vial that I could not well endure.

The like success I had in an Experiment wherein Oyl of Vitriol was mixt with common Brandy; save that in this the Heat produced seem'd not so intense as in the former Trial, which it self afforded not so fierce a Heat as that which was made with rectified Spirit of Wine.

EX-

EXPER. XVI.

THoſe Chymiſts, who conceive that all the Incaleſcencies of bodies upon their being mixt, proceed from their antipathy or hoſtility, will not perhaps expect, that the parts of the ſame body, (either numerically, or in *ſpecie*, as the Schools phraſe it,) ſhould, and that without manifeſt conflict, grow very hot together. And yet having for trials ſake put two ounces of *Colcothar* ſo ſtrongly calcin'd, that it was burnt almoſt to blackneſs, into a Retort, we poured upon it two ounces of ſtrong Oyl of Engliſh Vitriol, and found, that after about a minute of an hour they began to grow ſo hot, that I could not endure to hold my hand to the bottom of the Veſſel, to which the mixture gave a heat, that continued ſenſible on the outſide for between twenty and thirty minutes.

EX-

EXPER. XVII.

THough I have not obſerv'd any Liquor to equal Oyl of Vitriol in the number of Liquors with which it will grow hot; yet I have not met with any Liquor wherewith it came to a greater Incaleſcence than it frequently enough did with common *Oyl of Turpentine*. For when we cauſed divers ounces of each to be well ſhaken together in a ſtrong veſſel, faſten'd, to prevent miſchief, to the end of a pole or ſtaff; the Ebullition was great and fierce enough to be not undeſervedly admired by the Spectators. And this brings into my mind a pleaſant adventure afforded by theſe Liquors, of each of which, having for the Production of Heat and other purpoſes, caus'd a good bottle full to be put up with other things into a box, and ſent down into the Countrey with a great charge, that

that care ſhould be had of the Glaſſes; the Wagon, in which the box was carried, happen'd by a great jolt, that had almoſt overturn'd it, to be ſo rudely ſhaken, that theſe Glaſſes were both broken, and the Liquors, mingling in the box, made ſuch a noiſe and ſtink, and ſent forth ſuch quantities of ſmoke by the vents, which the fumes had open'd to themſelves, that the Paſſengers with great outcries and much haſte threw themſelves out of the Wagon, for fear of being burnt in it.

The Trials we made with Oyl of Turpentine, when ſtrong Spirit of Nitre was ſubſtituted in the ſtead of Oyl of Vitriol, belong not to this place.

EX-

EXPER. XVIII.

BUt though *Petroleum*, eſpecially when rectified, be, as I have elſewhere noted, a moſt ſubtile Liquor, and the lighteſt I have yet had occaſion to try; yet to ſhew you how much the Incaleſcence of Liquors may depend upon their Texture, I ſhall adde, that having mixt by degrees one ounce of rectified *Petroleum*, with an equal weight of ſtrong Oyl of Vitriol, the former Liquor ſeemed to work upon the Surface of this laſt named, almoſt like a *Menſtruum*, upon a metal, innumerous and ſmall bubbles continually aſcending for a while into the *Oleum Petræ*, which had its colour manifeſtly alter'd and deepen'd by the operation of the ſpirituous parts. But by all the action and re-action of theſe Liquors, there was produced no ſuch ſmoaking and boiling, or intenſe heat, as if Oyl of Turpentine

tine had been employed instead of Oyl of Vitriol; the change which was produc'd as to *Qualities* being but a kind of Tepidness discoverable by the Touch.

Almost the like success we had in the Conjunction of *Petroleum*, and Spirit of Nitre, a more full account whereof may be elsewhere met with.

In this and the late Trials I did not care to make use of Spirit of Salt, because, at least, if it be but ordinarily strong, I found its operation on the Liquors above mention'd inconsiderable, (and sometimes perhaps scarce sensible) in comparison of those of Oyl of Vitriol, and in some cases of dephlegm'd Spirit of Nitre.

EX-

EXPER. XIX.

EXperienced Chymists will easily believe, that 'twere not difficult to multiply Instances of Heat producible by Oyl of Vitriol upon solid bodies, especially Mineral ones. For 'tis known, that in the usual preparation of *Vitriolum Martis*, there is a great effervescence excited upon the affusion of the Oyl of Vitriol upon Filings of Steel, especially if they be well drench'd in common water. And it will scarce be doubted, but that, as Oyl of Vitriol will (at least partly) dissolve a great many both calcin'd and testaceous bodies, as I have try'd with Lime, Oyster-shells, &c. so it will, during the dissolution, grow sensibly, if not intensely hot with them, as I found it to do both with those newly named, and others, as Chalk, *Lapis Calaminaris*, &c. with the last of which, if the Liquor be strong, it will heat exceedingly.

EX-

EXPER. XX.

WHerefore I will rather take notice of its Operation upon Vegetables, as bodies which corroſive Menſtruums have ſcarce been thought fit to diſſolve and grow hot with. To omit then Cherries, and divers Fruits abounding in watery juices, with which, perhaps on that very account, Oyl of Vitriol will grow hot; I ſhall here take notice, that for trial ſake, having mixt a convenient quantity of that Liquor with Raiſins of the Sun beaten in a Mortar, the Raiſins grew ſo hot, that, if I miſremember not, the Glaſs that contain'd it had almoſt burnt my hand.

Theſe kind of Heats may be alſo produc'd by the mixture of Oyl of Vitriol with divers other Vegetable Subſtances; but, as far as I have obſerved, ſcarce ſo eminently with any dry body, as with the crumbs of white

white bread, (or even of brown) with a little of which we have ſometimes produced a ſurpriſing degree of Heat with ſtrong or well-dephlegm'd Oyl of Vitriol, which is to be ſuppos'd to have been employed in the foregoing Experiments, and all others mention'd to be made by the help of that Menſtruum in our Papers about Qualities, unleſs it be in any particular caſe otherwiſe declared.

EXPER. XXI.

'Tis as little obſerved that Corroſive Menſtruums are able to work, as ſuch, on the ſoft parts of dead Animals, as on thoſe of Vegetables, and yet I have more than once produced a notable Heat by mixing Oyl of Vitriol with minced fleſh whether roaſted or raw.

EX-

EXPER. XXII.

THough common Sea-ſalt does uſually impart ſome degree, though not an intenſe one, of Coldneſs unto common water, during the act of Diſſolution; yet ſome Trials have informed me, that if it were caſt into a competent quantity of Oyl of Vitriol, there would for the moſt part inſue an Incaleſcence, which yet did not appear to ſucceed ſo regularly, as in moſt of the foregoing Experiments. But that Heat ſhould be produc'd uſually, though not perhaps conſtantly, by the above-named Menſtruum and Salt, ſeems therefore worthy of our notice, becauſe 'tis known to Chymiſts, that common Salt is one main Ingredient of the few that make up common factitious Sal Armoniac; that is wont to be ſold in the Shops. And I have been inform'd, that the excellent Academians of *Florence* have

observed, that Oyl of Vitriol would not grow hot but cold by being put upon Sal Armoniac: Something like which I took notice of in rectified Spirit of Sulphur made *per Campanam*, but found the effect much more considerable, when, according to the Ingenious *Florentine* Experiment, I made the Trial with Oyl of Vitriol; which Liquor having already furnished us with as many *Phænomena* for our present purpose as could be well expected from one Agent, I shall scarce in this Paper about Heat make any farther use of it, but proceed to some other Experiments, wherein it does not intervene.

EX-

EXPER. XXIII.

WE took a good lump of common Sulphur of a convenient ſhape, and having rub'd or chaf'd it well, we found, as we expected, that by this attrition it grew ſenſibly warm; and, That there was an inteſtine agitation, which you know is Local Motion, made by this attrition, did appear not onely by the newly mention'd Heat, whoſe nature conſiſts in motion, and by the antecedent preſſure, which was fit to put the parts into a diſorderly vibration, but alſo by the ſulphureous ſteams, which 'twas eaſie to ſmell by holding the Sulphur to ones noſe, as ſoon as it had been rub'd. Which Experiment, though it may ſeem trivial in it ſelf, may be worth the conſideration of thoſe Chymiſts, who would derive all the Fire and Heat we meet with in ſublunary bodies from Sulphur. For in our caſe

a mass of Sulphur, before its parts were put into a new and brisk motion, was sensibly cold, and as soon as its parts were put into a greater agitation than those of a mans fingers, it grew sensibly hot; which argues, that 'twas not by its bare presence, or any emanative action, (as the Schools speak) that the Sulphur communicated any Heat to my hand; and also that, when 'twas briskly moved, it did impress that Quality, was no more than another solid body, though incombustible as common Glass, would have done, if its parts had been likewise put into an agitation surpassing that of my organs of feeling; so that in our Experiment, Sulphur it self was beholden, for its actual Heat, to Local Motion, produced by external agents in its parts.

EX-

EXPER. XXIV.

WE thought it not amiſs to try, whether when Sal Armoniac, that much infrigidates water, and Quick-lime, which is known to heat it, were by the fire exquiſitely mingled, the mixture would impart to the Liquor a moderate or an intenſe degree of either of thoſe Qualities. In proſecution of which Inquiry we took equal parts of Sal Armoniac and Quick-lime, which we fluxed together, and putting an ounce, by gheſs, of the powder'd mixture into a Vial with a convenient quantity of cold water, we found, that the colliquated maſs did, in about a minute, ſtrike ſo great a heat through the Glaſs upon my hand, that I was glad to remove it haſtily for fear of being ſcorched.

EXPER. XXV.

WE have given ſeveral, and might have given many more, Inſtances of the Incaleſcence of Mixtures, wherein both the Ingredients were Liquors, or at leaſt one of them was a fluid body. But ſometimes Heat may alſo be produc'd by the mixture of two powders; ſince it has been obſerved in the preparation of the Butter or Oyl of Antimony, that, if a ſufficient quantity of beaten Sublimate be very well mingled with powder'd Antimony, the mixture, after it has for a competent time (which varies much according to circumſtances, as the weather, veſſel, place, &c. wherein the Experiment is made) ſtood in the air, would ſometimes grow manifeſtly hot, and now and then ſo intenſely ſo, as to ſend forth copious and fetid fumes almoſt as if it would take fire. There is another Experiment

riment made by the help of Antimony, and a pulveriz'd body, wherein the mixture, after it had been for divers hours expos'd to the air, visibly afforded us mineral Fumes. And to these I could adde more considerable, and perhaps scarce credible, Instances of bodies growing hot without Liquors, if Philanthropy did not forbid me. But to return to our Butter of Antimony, it seems not unfit to be enquired, whether there do not unobservedly intervene an aqueous moisture, which (capable of relaxing the salts, and setting them a work) I therefore suspected might be attracted (as men commonly speak) from the air, since the mixture of the Antimony and the Sublimate is prescribed to be placed in Cellars; and in such we find, that Sublimate, or at least the saline part of it, is resolved *per deliquium*, (as they call it) which is nothing but a solution made by the watery steams wandering in the Air.

EXPER. XXVI.

I Have formerly deliver'd ſome Inſtances of the Incaleſcence produc'd by water in bodies that are readily diſſolv'd in it, as Salt of Tartar and Quick-lime. But one would not lightly expect, that meer water ſhould produce an Incaleſcence in ſolid bodies that are generally granted to be inſoluble in it; and are not wont to be, at leaſt without length of time, viſibly wrought on by it; and yet trial has aſſured me, that a notable Incaleſcence may be produc'd by common water in flower or fine powder of Sulphur, and Filings of Steel or Iron. For when, in Summer time, I caus'd to be mingled a good quantity, (as half a pound or rather a pound of each of the Ingredients) and caus'd them to be throughly drenched with common water, in a convenient quantity whereof they were very well ſtir-

red

red up and down, and carefully mingled, the mixture would in a ſhort time, perhaps leſs than an hour, grow ſo hot, that the Veſſel that contain'd it could not be ſuffer'd in ones hand; and the Heat was manifeſted to other Senſes than the Touch, by the ſtrong ſulphureous ſtink that invaded the noſe, and the thick ſmoak that aſcended out of the mixture, eſpecially when it was ſtirr'd with a ſtick or ſpattle. Whether the ſucceſs will be the ſame at all times of the year, I do not know, and ſomewhat doubt, ſince I remember not, that I had occaſion to try it in other Seaſons than in Summer, or in Autumn.

EX-

EXPER. XXVII.

IN the Instances that Chymistry is wont to afford us of the Heat produc'd by the action of Menstruums upon other bodies, there intervenes some liquor, properly so call'd, that wets the hands of those that touch it; and there are divers of the more judicious Chymists, that joyn with the generality of the Naturalists in denying, that Quicksilver, which is indeed a fluid body, but not a moist and wetting one in reference to us, will produce Heat by its immediate action on any other body, and particularly on Gold. But though I was long inclinable to their opinion, yet I cannot now be of it, several Trials having assur'd me, that a Mercury, whether afforded by Metals and Minerals, or impregnated by them, may by its preparation be enabled to insinuate it self nimbly into the body

body of Gold, whether calcin'd or crude, and become manifeſtly incaleſcent with it in leſs than two or three minutes of an hour.

EXPER. XXVIII.

SInce we know that ſome natural Salts, and eſpecially Salt-peter, can produce a Coldneſs in the water they are diſſolved in, I thought it might not be impertient to our enquiry into Heat and Cold, and might perhaps alſo contribute ſomewhat to the diſcovery of the Structure of Metals, and the ſalts that corrode them, if Solutions were made of ſome Saliform'd bodies, as Chymiſts call them, that are made up of metalline and ſaline parts, and do ſo abound with the latter, that the whole Concretions are on their account diſſoluble in common water.

Other

Other Experiments of this ſort belonging leſs to this place than to another, I ſhall here onely for example ſake take notice of one that we made upon Quickſilver, which is eſteem'd the coldeſt of Metals. For having by diſtilling from it four times its weight of Oyl of Vitriol, reduc'd it to a powder, which on the account of the adhering Salts of the Menſtruum that it detain'd, was white and gliſtering, we put this powder into a wide-mouth'd Glaſs of water, wherein a ſeal'd Weather-glaſs had been left before it began manifeſtly to heat the water, as appear'd by the quick and conſiderable aſcent of the tincted Spirit of Wine, that continued to riſe upon putting in more of the Magiſtery; which warm event is the more remarkable, becauſe of the obſervation of *Helmont*, that the Salt adhering to the Mercury, corroded in good quantity by Oyl of Vitriol,

if

if it be washed off and coagulated, becomes a kind of Alom.

The event of the former Trial deserves the more notice, because having after the same manner and with the same Weather-glass made an Experiment with common water, and the powder of *Vitriolum Martis*, made with Oyl of Vitriol and the Filings of Steel, the tincted Spirit of Wine was not at all impell'd up as before, but rather, after a while, began to subside, and fell, though very slowly, about a quarter of an inch. The like Experiment being tried with powder'd Sublimate in common water, the liquor in the Thermoscope was scarce at all sensibly either rais'd or depress, which argued the alteration as to Heat or Cold, to have been either none or very inconsiderable.

[Having

Having given warning at the beginning of this Section, that in it I aimed rather at offering various than numerous Experiments about the Production of Heat, I think what has been already deliver'd may allow me to take leave of this Subject without mentioning divers Instances that I could easily adde, but think it fitter at present to omit. For those afforded me by Trials about *Antiperistasis* belong to a Paper on that Subject. Those that might be offer'd about Potential Heat in humane bodies, would perchance be thought but unnecessary after what has been said of Potential Coldness; from which an attentive Considerer may easily gather, what according to our Doctrine is to be said of the contrary Quality. And divers *Phænomena*, which would have been of the most considerable I could have mentioned of the Production of Heat,

since

ſince in them that Quality is the moſt exalted, I reſerve for the Title of *Combuſtibleneſs* and *Incombuſtibility*, having already ſuffer'd this Collection (or rather Chaos) of Particulars *about the Production of Heat* to ſwell to too great a bulk.

FINIS.